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Eurocontrol ATN Trials End System - Status Update

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SUMMARY

This paper provides the Working Group with a status report on the Eurocontrol Trials End System (TES), an implementation of the ICAO Doc 9705 ATN upper layers, ADS, CM and CPDLC applications. TES is a component of the Eurocontrol ATN Trials Infrastructure (ATIF).

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1. INTRODUCTION

This paper provides a status report on the Eurocontrol Trials End System (TES) development, an implementation of the ICAO Doc 9705 ATN upper layers, ADS, CM and CPDLC applications.

This is an update to papers presented at previous meetings of the Working Group which have described the overall concept, implementation approach and validation results obtained from the TES project (see list of references for details). It describes TES developments and plans since the previous report to the Working Group in March 1998.

A previous version of the TES software was demonstrated at the ATNP WG Langen meetings in June 1997.

TES is a component of the Eurocontrol ATN Trials Infrastructure (ATIF). Together with the Trials ATN Router (TAR) / Trials Transport Server (TTS), ATIF provides a complete 7-layer ATN trials environment.

1.1. References

[1] ATNP/WG3/WP4-13 Approach to Validation of CNS/ATM-1 Package SARPs

[2] ATNP/WG3/WP9-23 Results from Eurocontrol Application SARPs Validation

[3] ATNP/WG3/WP9-24 Implementation of Eurocontrol CNS/ATM-1 Trials End System (TES)

[4] ATNP/WG3/WP9-25 Eurocontrol ATN Project Overview and Status

[5] ATNP/WG3/WP10-23 Eurocontrol Trials End System (TES) - Status Update

[6] ATNP/WG3/WP11-21 Eurocontrol ATN Trials End System

[7] TES user documentation: ASI API Programmer's Guide, DED6/TES/RELEASE/TES-C/ASIGV3_0

[8] TES user documentation: Introduction to TES Release C, DED6/TES/RELEASE/TES-C/INTRO2_1.

2. TES GENERAL DESCRIPTION

The TES software implements :

- The air-ground functionality of the Automatic Dependant Surveillance (ADS) application,
- The air-ground functionality of the Controller Pilot Data Link Communication (CPDLC) application,
- Both the air-ground and ground-ground functionality of the Context Management (CM) application,
- The ATN Upper Layers (Session layer efficiency enhancement option, Presentation layer efficiency enhancement option, ACSE edition 2 and Control Function).

Details of TES compliance to the functional configurations (subsets) defined in Doc 9705 are presented in Table 1.

Table 1. TES Functional Baseline

	Ground ASE	Air ASE
CM	**Configuration XXVIII** (full functionality) - Logon service - Update service - Contact service - Ground forwarding service - Maintain dialogue option	**Configuration I** (full functionality) - Logon service - Update service - Contact service - Maintain dialogue option
CPDLC	**Configuration II** - Core CPDLC service - DSC service - receive/reject Forward - all message elements	**Configuration II** (full functionality) - Core CPDLC service - DSC service - all message elements
ADS	**Configuration VII** (full functionality) - Demand Contract - Event Contract - Periodic Contract - Emergency Mode	**Configuration I** (full functionality) - Demand Contract - Event Contract - Periodic Contract - Emergency Mode
ADS Report Forwarding	Not implemented	Not implemented
FIS (ATIS)	Not implemented	Not implemented

These services are made available to user applications via exposed application programming interfaces (APIs), including an API at the Dialogue Service level.

The TES software provides access to the application services specified in the selected SARPs. It does NOT implement the “user part” of the application, and it does NOT include any end-user command-line or graphical interface.

The TES software does NOT implement the ATN internet communications service (ICS); it relies on the services of TAR-TTS or an alternative transport service provider for this. It does NOT implement the FIS (ATIS) air-ground application, nor the ATSMHS or AIDC ground-ground applications.

Commercial off-the-shelf (COTS) tools are used for the purpose of controlling and monitoring the TES software (starting and stopping processes, setting up traces, etc.) and may also be used for developing and executing test scenarios at the API level.

TES is available for free issue for experimental purposes to Eurocontrol Member Administrations. A four-day training course is available.

3. CURRENT STATUS

The TES software is now at Release C.

The TES software has been tested on a number of UNIX-based platforms, including HP-UX versions 9 and 10, and (for airborne applications) PCs running SUN Solaris 2.5.1 /x86. A common set of source files is used on all supported platforms.

The initial TES release (Release A) was an implementation of the draft ICAO SARPs dated June 1996 (the so-called “Munich output” versions), together with some defect resolutions which were essential for the correct functioning of the software.

In Release B, the TES software was updated to conform to the ICAO SARPs versions of March 1997 (the so-called “ICAO V1.1” or “Phuket output” versions). This is the version which was placed under formal change control by the ICAO ATN Panel.

Also in Release B, a set of “Formatting / Unformatting Functions” (FUFs - see section 3.2) was fully supported and documented for the first time, providing user-friendly access to the complex data structures at the TES APIs.

With Release C, the following new features and improvements are introduced:

- Protocol compatibility with the published ATN SARPs (ICAO Doc 9705)
- Alignment of identifier names with Doc 9705, to the extent possible (note that in Doc 9705 different applications in some cases define the same variables differently, e.g. latitude and longitude)
- General usability improvements, including rationalisation of header files
- Provision of CPDLC RouteClearance and DepartureClearance formatting and unformatting functions (FUFs), to complete the set of provided FUFs.
- Increase in the maximum number of aircraft users
- Improved compatibility with C++ compilers
- Default for QoS parameter checking changes in entity configuration files, so that QoS checking is enabled by default.
- Correction to setting of Priority parameters when used with TAR/TTS
- Examples of user applications (FITAMS applications).
- Remote Procedure Call (RPC) access to the main application (ASI) functions.
- Finally, a small number of problems reported in the previous release have been solved in the current release.

3.1. Interoperability

Note that, because of the evolution of ICAO SARPs prior to formal publication, TES Release B is NOT in general capable of interworking with TES Release A, and TES Release C is NOT in general capable of interworking with earlier releases.

For the CM application, TES Release C will interwork with implementations of the First Edition of ICAO Doc 9705, and also with implementations of the draft SARPs known as ICAO V2.2. It will also interwork with implementations of draft SARPs V1.1 (including TES-B), with the exception of Abort handling in certain protocol error situations.

For the CPDLC application, TES Release C will interwork with implementations of the First Edition of ICAO Doc 9705, and also with implementations of the draft SARPs known as ICAO V2.2. It will NOT interwork with implementations of draft SARPs V1.1 (including TES-B) or earlier, due to fundamental differences in the encoding of uplink and downlink messages.

For ADS, TES Release C will interwork at the protocol level with implementations of the First Edition of ICAO Doc 9705, and also with implementations of the draft SARPs known as ICAO V2.2. Further, it is believed that TES Release C is capable of interworking with V1.1

implementations (such as TES Release B), i.e. they are “bits-on-the-wire” compatible. Interworking at the operational level is less well defined.

For ULCS and the Dialogue Service, TES Release C will interwork at the protocol level with implementations of the First Edition of ICAO Doc 9705, and also with implementations of the draft SARPs known as ICAO V2.2. Further, it is believed that TES Release C is capable of interworking with V1.1 implementations (such as TES Release B), i.e. they are “bits-on-the-wire” compatible.

3.2. Application Programming Interfaces

TES provides ASI APIs for CM, ADS and CPDLC applications, and also an exposed dialogue service interface (DSI) API, and an addressing database and a local management interface.

The TES interface specification documents are:

- ASIG - the ASI-level API programmer’s guide
- DSIG - the Dialogue Service API programmer’s guide
- ADBG - the Addressing Database API programmer’s guide
- OPEG - the Operator (local manager) API programmer’s guide.

These TES interfaces are at the same level as the ProATN EID specification. The API-user is presented with C language data structures which must be populated before invoking the API call when sending, and must be interpreted after invoking the API call when receiving.

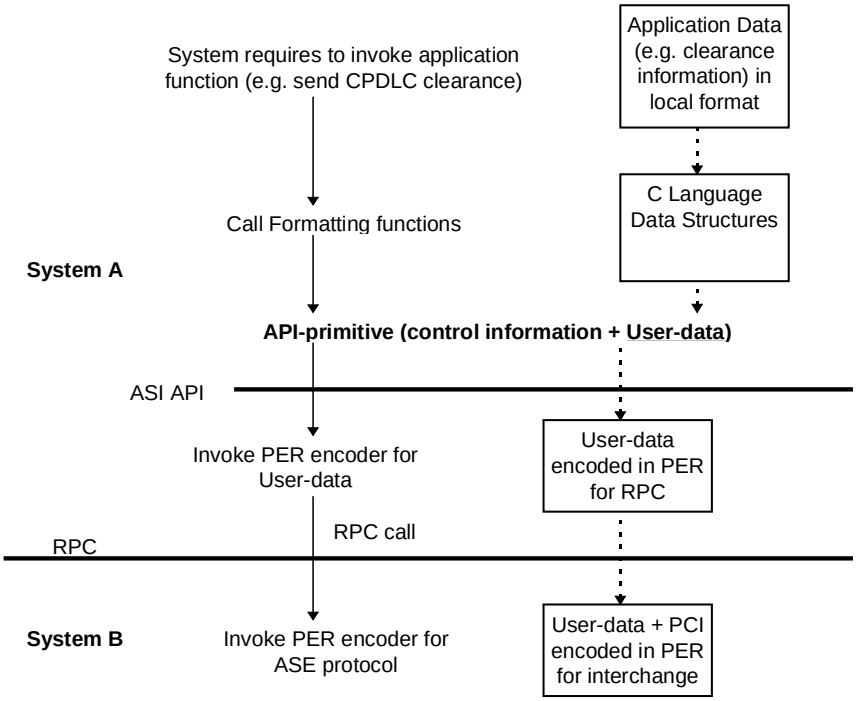

Figure 1: Interface Functionality with TES ASI and RPC interfaces

TES also provides a higher-level interface in the form of a library of Formatting / Unformatting Functions (FUFs). These provide the user with function calls to handle the various elements of the ASN.1-defined User-data, and so hide the underlying complex C structures from the API user.

TES provides Remote Procedure Call (RPC) access, such that the protocol handling (ASE) and communications stack may be physically located on a different processor than the user part and encoding of User-data.

This is illustrated in Figure 1.

3.3. Interface Compatibility

The TES implementation has exposed interfaces which are very similar to those defined in the ProATN External Interface Definition (EID). On the whole, the TES and ProATN external interfaces are closely aligned at the functional level. There are, however, some significant differences of detail.

The ATNSI ASE EICD is also functionally similar at the ASI level, but differs in that it assumes that PER encoding and decoding of User-data is performed by the user of the interface. This tends to make it more resilient to any future SARPs changes at the message definition level.

The various application interface specifications fall into a hierarchy of complexity from the User point of view, as illustrated in Figure 2.

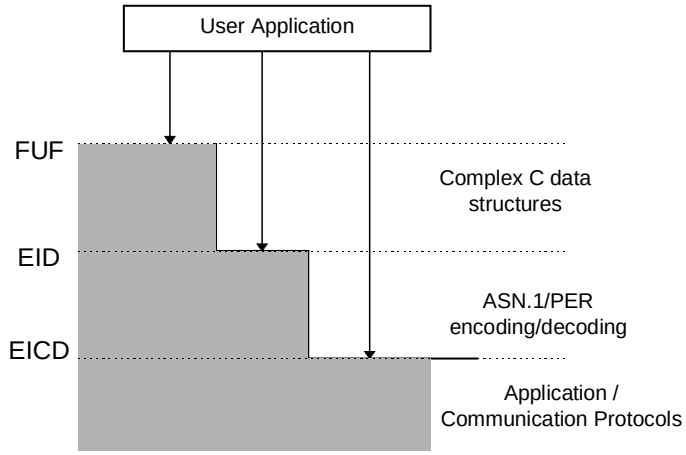

Figure 2. ASI Interface Comparison

Both TES and ProATN interface definitions include similar sets of procedure calls for:

- API administration (initialisation, registration, received event handling, de-registration and termination)
- the ADS application
- the CM application
- the CPDLC application
- an addressing database (ADB)

The ProATN interface currently assumes compliance to the ICAO V1.1 (ex-Phuket) SARPs, with some PDR changes. Future compliance to the published ICAO Doc. 9705 would require some changes at the API level, particularly for CPDLC. In addition the implementation of PDRs will impact the API and more importantly the communication stack interoperability.

Major differences in functionality between the interfaces are:

TES includes the Formatting and Unformatting functions (FUFs) which hide the complexity of the exposed data structures from the API user, and handle memory management. There are no equivalent functions defined in the ProATN EID or ATNSI EICD.

TES and ProATN EID provide C data structures for the User-data, while EICD assumes the User-data is already PER-encoded as a bitstream.

TES and RRI EICD include an exposed API at the Dialogue Service level (as defined in the ULCS SARPs). There is no equivalent in the ProATN EID.

ProATN and ATNSI include the FIS (ATIS) application; TES does not.

ProATN differentiates the Air and Ground interfaces; TES and EICD do not.

The impact of these differences is that applications written to utilise the ProATN EID and TES API respectively will not be able to be ported directly from one stack to the other without additional integration software being provided.

It would be possible, with some re-mapping of the encoded User-data, to re-use parts of the ProATN or TES implementations over a STREAMS-based interface such as that defined in the EICD.

3.4. Details of Implemented PDR Resolutions

TES Release A was based on the draft SARPs released as the output version of the ATNP/WG3 meeting in Munich in June 1996.

TES Release B was based on the post-ATNP/2 draft SARPs produced by the WG3 meeting in Phuket in March 1997 (proposed ICAO version 1.1). Since March 1997, defect reports have been handled by the ATNP Change Control Board (CCB).

The goal for TES Release C was compatibility with the ATN technical provisions published as the first edition of ICAO Doc 9705. TES was originally based on the first stable drafts of the ATN SARPs. Since then, a number of defect reports have been adopted in Doc 9705, resulting in functional and protocol changes. In TES Release C, all defect resolutions that affect interoperability at the protocol ("bits-on-the-wire") level have been implemented. The following list shows these defect resolutions:

CM

97100006	CM Exception Handling Correction

CPDLC

97060009	CPDLC Facility Designation
97060011	CPDLC LatLong
97080010	CPDLC Modification Unit Name Definition
97080011	CPDLC Proposed Change to ASN.1
97100008	CPDLC Position Report Format Change in PANSRAC
97100010	CPDLC Incorrect Range for LevelFeet Parameter
97100011	CPDLC Reduction on Potential Message Size
97100013	CPDLC Additional Traffic Type
97100015	CPDLC/AIDC Airway Name changed to ATSRouteDesignator
97100016	CPDLC/AIDC VHFFrequency/VHFFrequencyChannel
97100019	CPDLC ASN.1 Definition of Facility Function
97100026	CPDLC Exception Handling Correction
97100036	CPDLC Change name DistanceOffset to DistanceSpecified
97100037	CPDLC reserved message element

97100039	CPDLC - Route Clearance
98050019	ICAO Doc 9705 naming defects

ADS

97080005	ADS Invalid ASN.1

4. EXAMPLE OF USAGE

The TES software has been supplied to several Eurocontrol Member States to assist in their ATN evaluation and trials activities. This section gives an example of the type of trials activities being undertaken.

The FITAMS (Flight Trials of ATN over Multiple Subnetworks) initiative, part of the Eurocontrol ATN Infrastructure (ATIF) project, provided the first flight demonstration of end-to-end communication over a fully SARPs compliant 7-layer ATN network over multiple air-ground subnetworks. The trials were carried out using the DERA BAC 1-11 aircraft using the ATIF TAR-TTS-TES equipment both in the air and on the ground. Early trials were based on TES version B, and focussed on the CPDLC and ADS applications.

CPDLC exchanges using the CPDLC-Start, CPDLC-End and CPDLC-Message services have been demonstrated with a Current Data Authority, using a simplified message set of approximately 50 uplink and 17 downlink messages. On the aircraft side, a Data Link Terminal based on a touch sensitive LCD screen was employed to display incoming messages to the flight deck crew, and allow them to select a message for the response. On the ground, a window based TCL/TK user interface was used to display incoming and select outgoing messages.

ADS has been demonstrated using the Periodic Contract service, providing Position, Time Stamp, FOM, Air Vector, Ground Vector, and Weather reports from the aircraft. Historical aircraft track derived from these ADS reports was illustrated on a ground map display.

Future work will focus on integrating the ATIF equipment into the PETAL II trials environment, and the first step towards this has been taken with the upgrade of the existing applications to operate with TES version C. CPDLC has been extended to support the Next Data Authority procedures, and the message set is being expanded to conform with the full PETAL II requirements. Context Management has been added, so as to support the CM-logon and CM-contact services.

Provision has been made to incorporate a PETAL Service Function (PSF) into the aircraft application architecture, to accommodate the additional functionality which falls outside the current application SARPs, but which is required to support the PETAL Service definitions. This will be implemented once the PETAL Specifications are mature.

Corresponding enhancements are also being made to the Data Link Terminal, to allow the flight deck drew to input CM initialisation information, and to support crew initiated CM and CPDLC control. An extended repertoire of downlink messages is being incorporated, and features are being added to reduce pilot workload, such as context sensitive response generation, and automatic completion of parameters in accordance with the PETAL service definitions.

The FITAMS applications have been successfully ported to TES-C, and make use of the high-level Formatting / Unformatting (FUF) interfaces.

5. FUTURE PLANS

Further evolution of TES has now been phased out as the transition to ProATN deployment takes place. This move fits the Eurocontrol ATN strategy to move to pre-operational systems.

TES is now in the maintenance phase and is still actively supported. It will continue to be used for airborne flight trials for the foreseeable future.

6. CONCLUSIONS

The Eurocontrol TES software played a major role in ATNP/2 SARPs validation and continues to be important for ATN trials and exploitation. It continues to be available for free distribution to Eurocontrol Member States.

This paper has provided the Working Group with a brief update of the status of the TES implementation. Members are invited to contact the Eurocontrol ATN Project for further details and / or a demonstration.

6.1. Contact Details

The TES software is supplied by:

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